

## C4203 Log Data Report

### Borehole Information:

<b>Borehole:</b> C4203		<b>Site:</b> 216-U-1 & 2 Cribs			
<b>Coordinates</b> (WA State Plane)		<b>GWL (ft)<sup>1</sup>:</b> Dry	<b>GWL Date:</b> 01/27/2004		
<b>North</b>	<b>East</b>	<b>Drill Date</b>	<b>TOC<sup>2</sup> Elevation</b>	<b>Total Depth (ft)</b>	<b>Type</b>
Not Available	Not Available	Feb. 2004	Not Available	50	Push Hole

### Casing Information:

<b>Casing Type</b>	<b>Stickup (ft)</b>	<b>Outer Diameter (in.)</b>	<b>Inside Diameter (in.)</b>	<b>Thickness (in.)</b>	<b>Top (ft)</b>	<b>Bottom (ft)</b>
Threaded steel	0.1	7	6	1/2	0.1	48.5

### Borehole Notes:

Casing diameter was measured using a caliper and a steel tape, and measurements were rounded to the nearest 1/16 in.

### Logging Equipment Information:

<b>Logging System:</b>	Gamma 1E	<b>Type:</b>	SGLS (70%) 34TP40587A
<b>Calibration Date:</b>	01/2004	<b>Calibration Reference:</b>	GJO-2004-568-TAC
		<b>Logging Procedure:</b>	MAC-HGLP 1.6.5, Rev. 0

### Spectral Gamma Logging System (SGLS) Log Run Information:

<b>Log Run</b>	<b>1</b>	<b>2 /</b>	<b>3 Repeat</b>		
Date	02/11/04	02/11/04	02/11/04		
Logging Engineer	Spatz	Spatz	Spatz		
Start Depth (ft)	49.0	48.0	35.0		
Finish Depth (ft)	49.0	0.0	30.0		
Count Time (sec)	100	100	100		
Live/Real	R	R	R		
Shield (Y/N)	N	N	N		
MSA Interval (ft)	1.0	1.0	1.0		
ft/min	N/A <sup>3</sup>	N/A	N/A		
Pre-Verification	AE083CAB	AE083CAB	AE083CAB		
Start File	AE083000	AE083001	AE083050		
Finish File	AE083000	AE083049	AE083055		
Post-Verification	AE085CAA	AE085CAA	AE085CAA		

Log Run	1	2 /	3 Repeat		
Depth Return Error (in.)	0	0	0		
Comments	No fine-gain adjustment.	No fine-gain adjustment.	No fine-gain adjustment.		

### **Logging Operation Notes:**

Logging was performed with a centralizer installed on the sonde. Pre- and post-survey verification measurements for the SGLS employed the Amersham KUT ( $^{40}\text{K}$ ,  $^{238}\text{U}$ , and  $^{232}\text{Th}$ ) verifier with serial number 118. Logging started (log run 1) with the sonde tip at the bottom of the borehole at a logging depth of 49.0 ft. The sonde was then raised to the nearest 1.0-ft interval (48.0 ft) above total depth to continue with the logging (log run 2). Zero reference is the ground surface.

### **Analysis Notes:**

<b>Analyst:</b>	Henwood	<b>Date:</b>	02/17/04	<b>Reference:</b>	GJO-HGLP 1.6.3, Rev. 0
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SGLS pre-run and post-run verification spectra were collected at the beginning and end of the day. All of the verification spectra were within the acceptance criteria. However, the efficiency for the relatively high-energy 2614-keV photo peak apparently deteriorated (as determined from comparison of the pre- and -post verification spectra) during the day of logging. This deterioration results in less counts being acquired in peaks at higher energies (i.e., greater than approximately 1800 keV). Therefore, the detection and quantification of man-made radionuclides (normally measured between 186 and 1333 keV) are not affected. Otherwise, examinations of spectra indicate that the detector functioned normally during logging, and the spectra are accepted.

Log spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Verification spectra were used to determine the energy and resolution calibration for processing the data using APTEC SUPERVISOR. Concentrations were calculated in EXCEL (source file: G1EJan04.xls). Zero reference was the ground surface. Based on the field measurements, the casing configuration was assumed as one string of 6-in. casing with a thickness of 1/2 in. to 49.0 ft (total logging depth). The dead time correction is applied when the dead time exceeds 10 percent. Where dead time exceeds 40 percent, pulse pileup and peak spreading occurs such that quantification of radionuclides causes greater uncertainty. A water correction was not required.

### **Log Plot Notes:**

Separate log plots are provided for gross gamma and dead time, naturally occurring radionuclides ( $^{40}\text{K}$ ,  $^{238}\text{U}$ , and  $^{232}\text{Th}$ ), and man-made radionuclides. Plots of the repeat logs versus the original logs are included. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, or casing correction. These errors are discussed in the calibration report. A combination plot is also included to facilitate correlation. The  $^{214}\text{Bi}$  peak at 1764 keV was used to determine the naturally occurring  $^{238}\text{U}$  concentrations on the combination plot rather than the  $^{214}\text{Bi}$  peak at 609 keV because it exhibited slightly higher net counts per second.

### **Results and Interpretations:**

$^{137}\text{Cs}$ , processed uranium ( $^{238}\text{U}$  and  $^{235}\text{U}$ ),  $^{60}\text{Co}$ , and possibly  $^{90}\text{Sr}$  were the man-made radionuclides detected in this borehole.  $^{137}\text{Cs}$  was detected near the ground surface at approximately 0.5 pCi/g and in the

interval between 30 and 39 ft with concentrations ranging from 0.3 to 160 pCi/g. The maximum concentration was measured at 32.0 ft.

$^{60}\text{Co}$  was measured at 37 and 39 ft; the maximum concentration was approximately 8 pCi/g at 37 ft. It is likely  $^{60}\text{Co}$  also exists at 38 ft but was not detected as a result of high gamma activity in this high dead time interval.

$^{238}\text{U}$  as inferred from the  $^{234\text{m}}\text{Pa}$  1001-keV energy peak was detected between 31 and 46 ft. The maximum concentration was 389 pCi/g at 38.0 ft.  $^{235}\text{U}$ , which is measured directly by the 186-keV energy peak, is usually detected where the  $^{234\text{m}}\text{Pa}$  energy peak is detected at a ratio of approximately 1:20.  $^{235}\text{U}$  was not detected as a result of an elevated Compton scattering at energies below approximately 300 keV. This downscattering occurred as a result of the relatively high  $^{137}\text{Cs}$  and  $^{238}\text{U}$  between 30 and 36 ft. Between 36 and 49 ft, evidence of  $^{90}\text{Sr}$  exists. As the high-energy (up to 2.3 MeV) beta radiation from  $^{90}\text{Sr}$  interacts with the steel casing, low-energy gamma radiation (*bremstrahlung*) can be observed in the total gamma-ray count rate. This radiation also obscures the low-energy gamma peaks such as the 186-keV  $^{235}\text{U}$  peak.

The plots of the repeat logs demonstrate reasonable repeatability of the SGLS data for the natural radionuclides at energy levels of 1461, 1764, and 2614 keV and the man-made radionuclides at 662 and 1001 keV.

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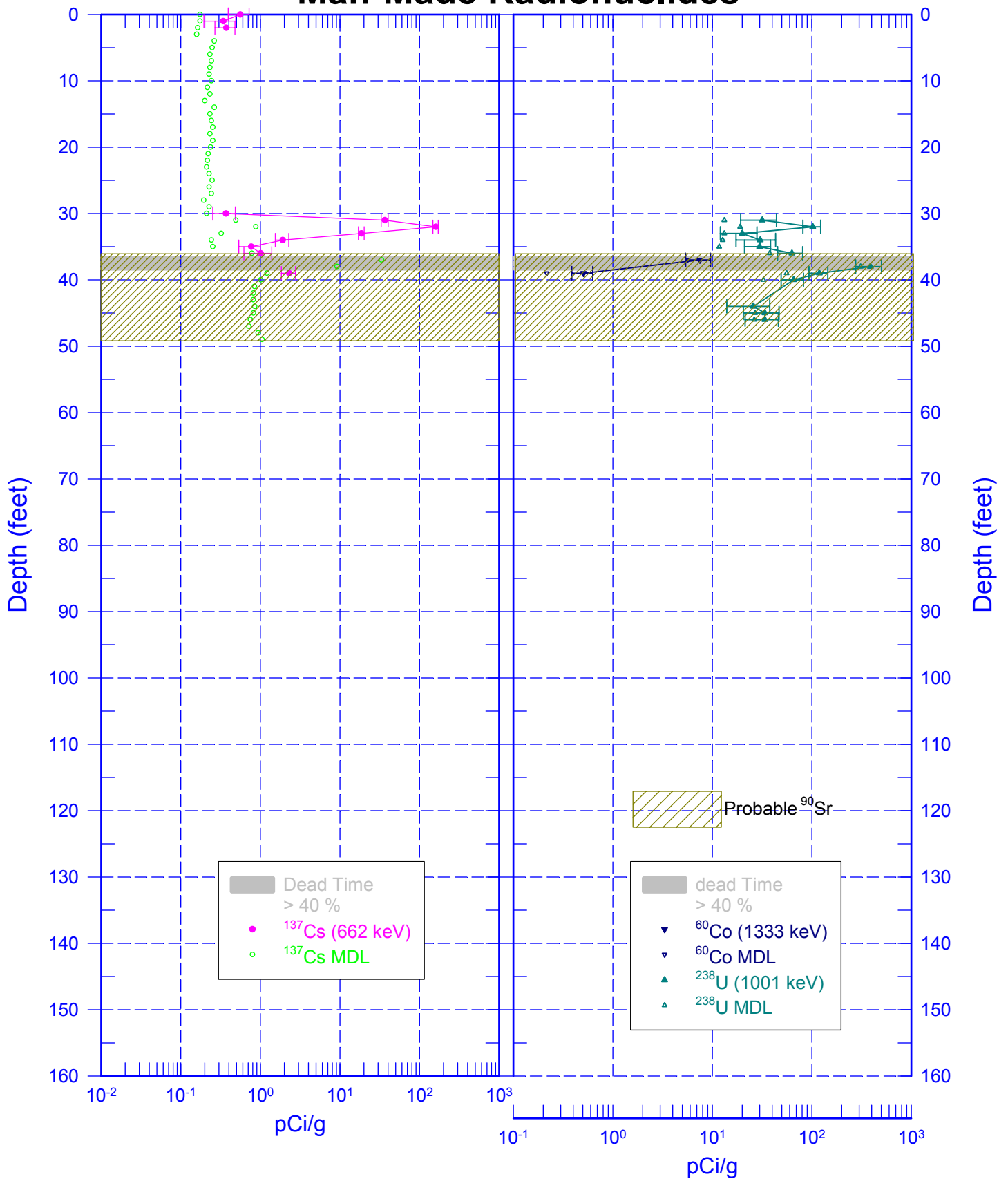
<sup>1</sup> GWL – groundwater level

<sup>2</sup> TOC – top of casing

<sup>3</sup> N/A – not applicable

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## Man-Made Radionuclides



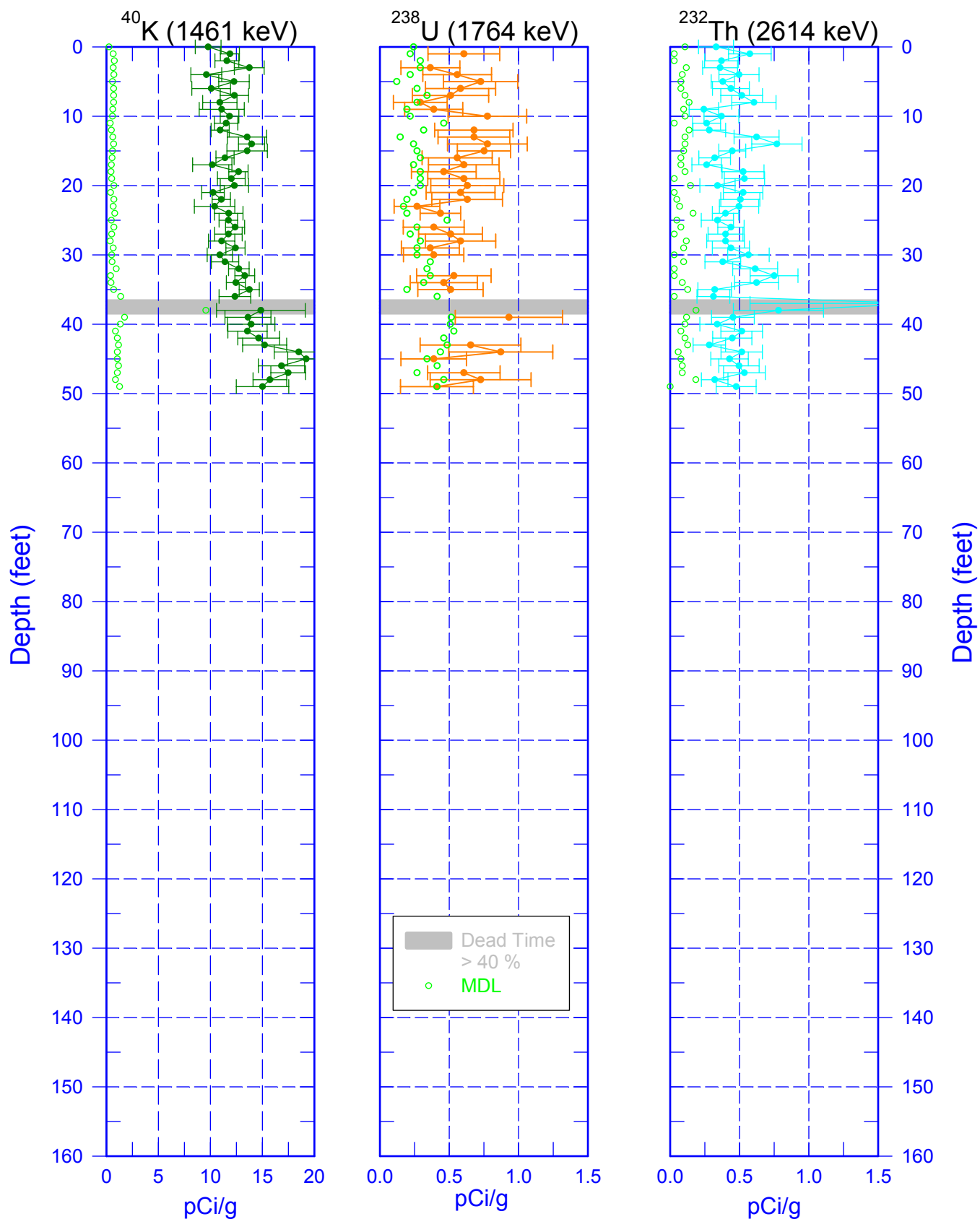
Zero Reference = Ground Surface

Depth Scale: 1"=20 ft

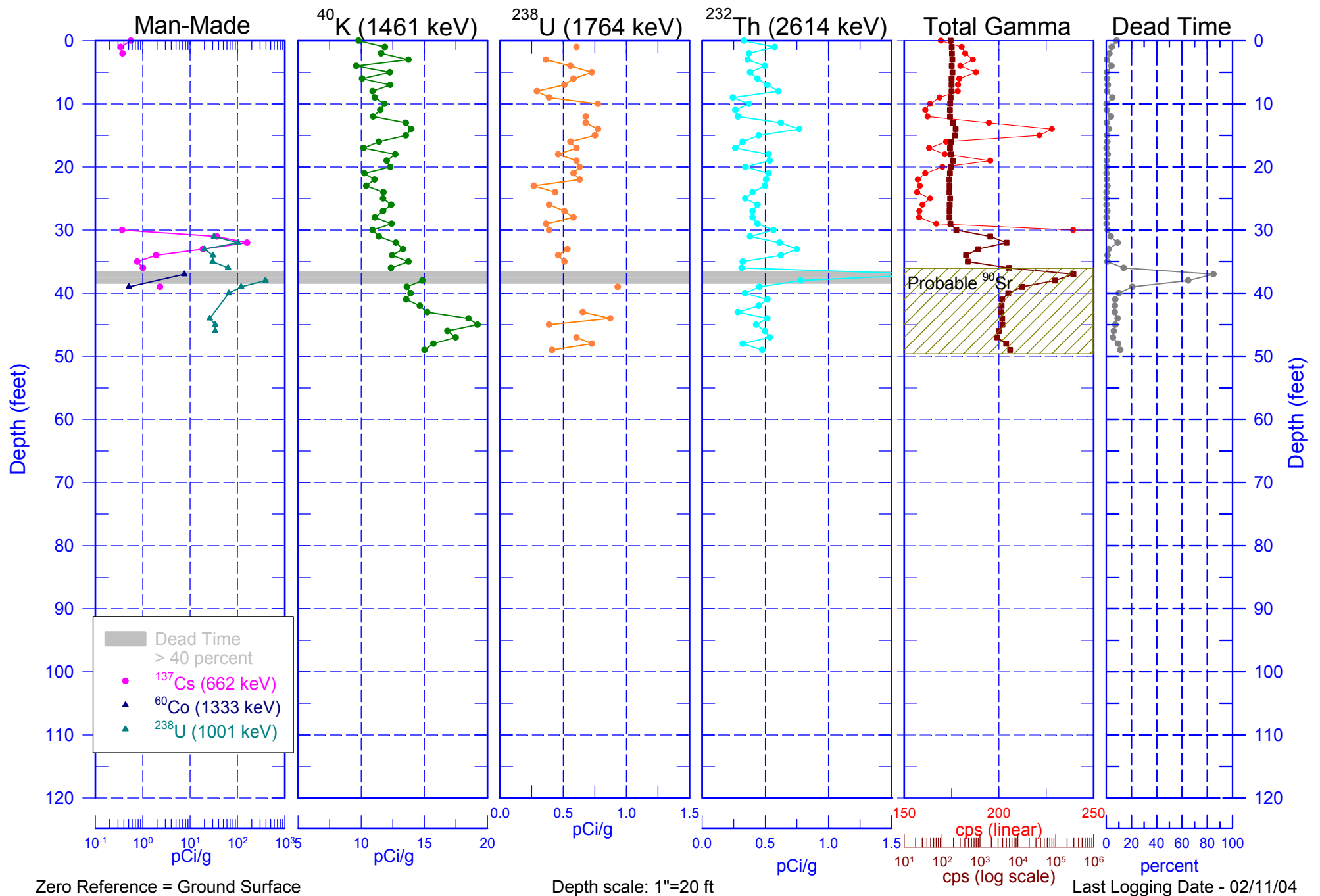
Last Log Date - 02/11/04

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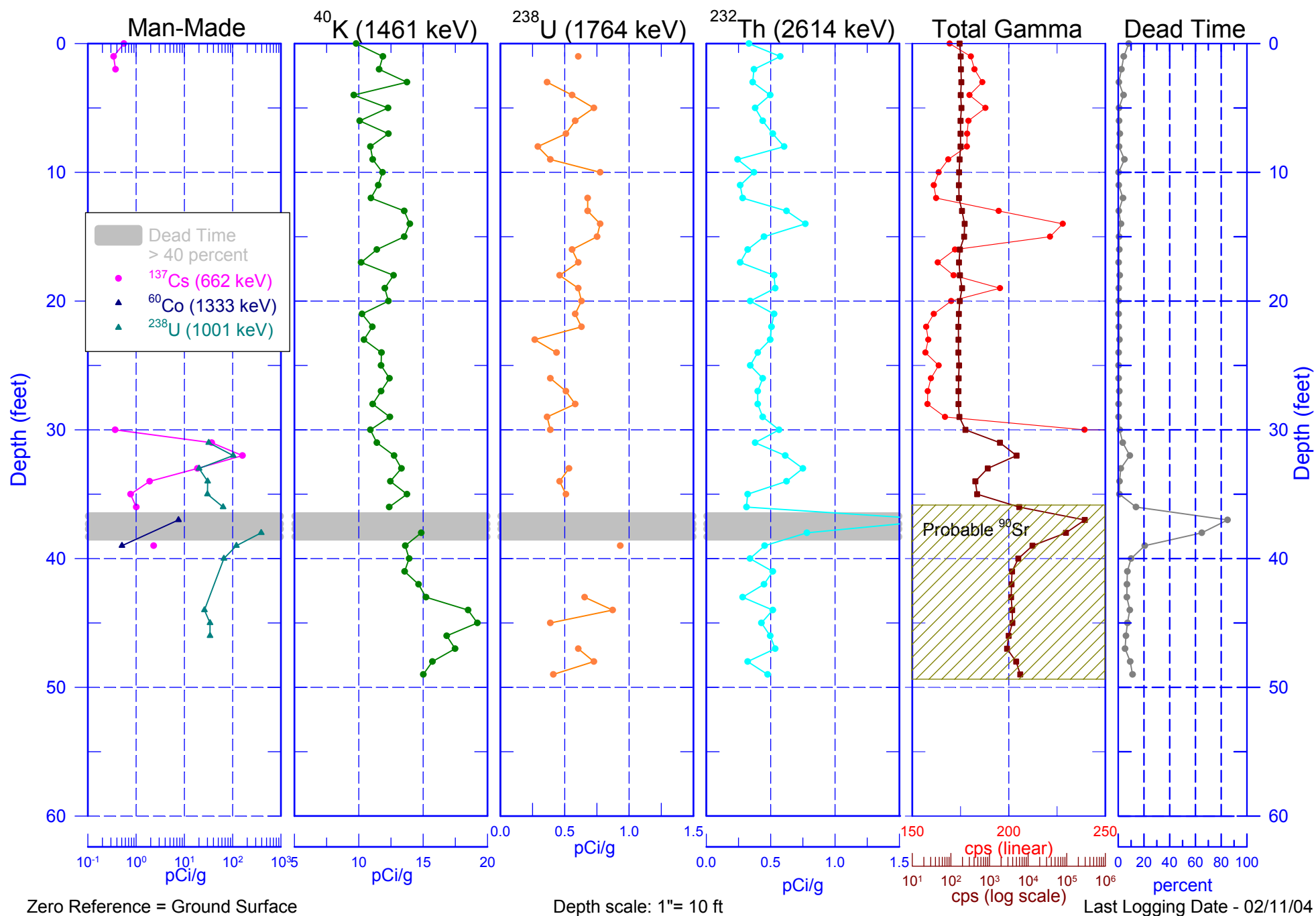
## Natural Gamma Logs



## C4203 Combination Plot

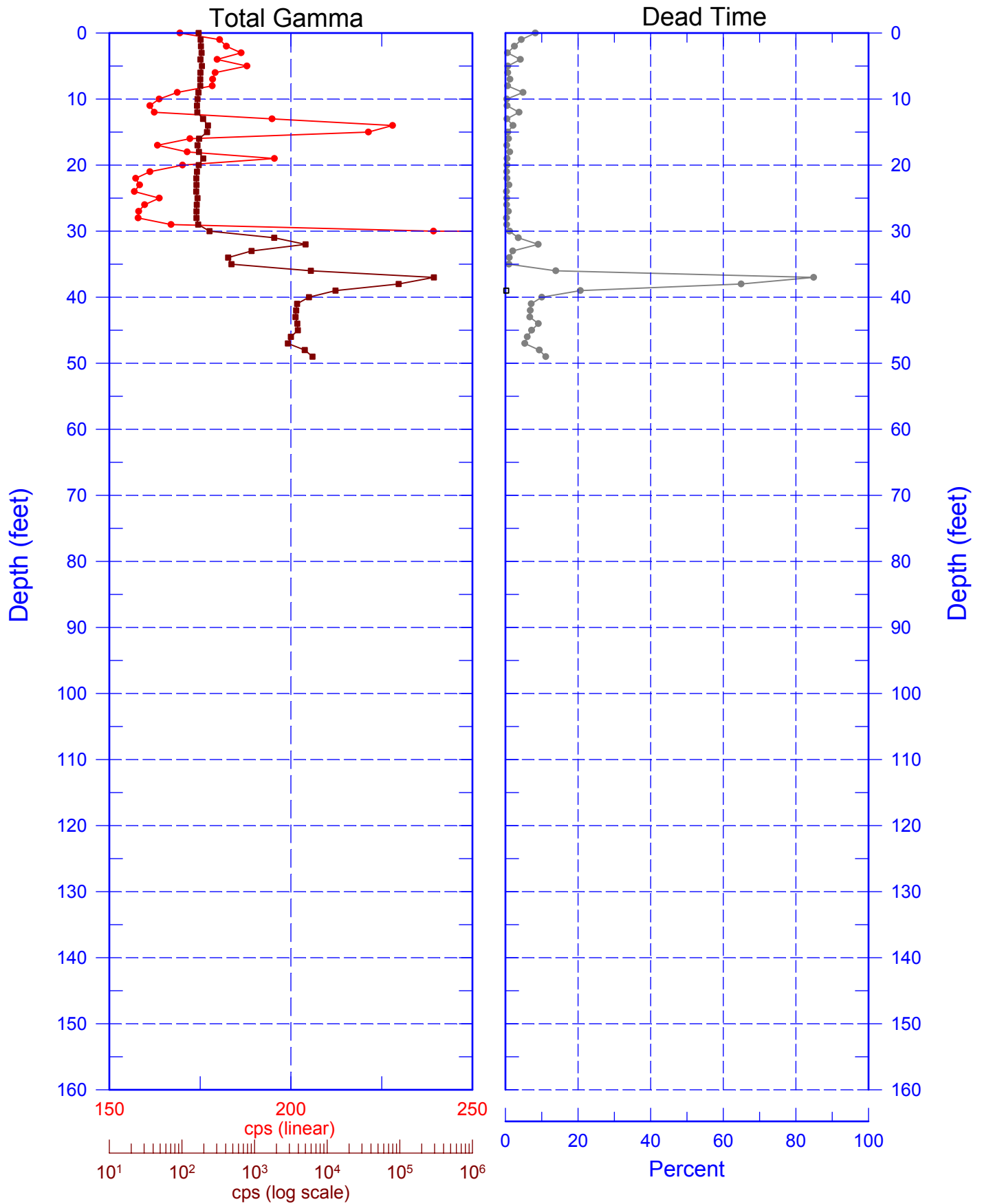


# C4203 Combination Plot



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## Total Gamma & Dead Time



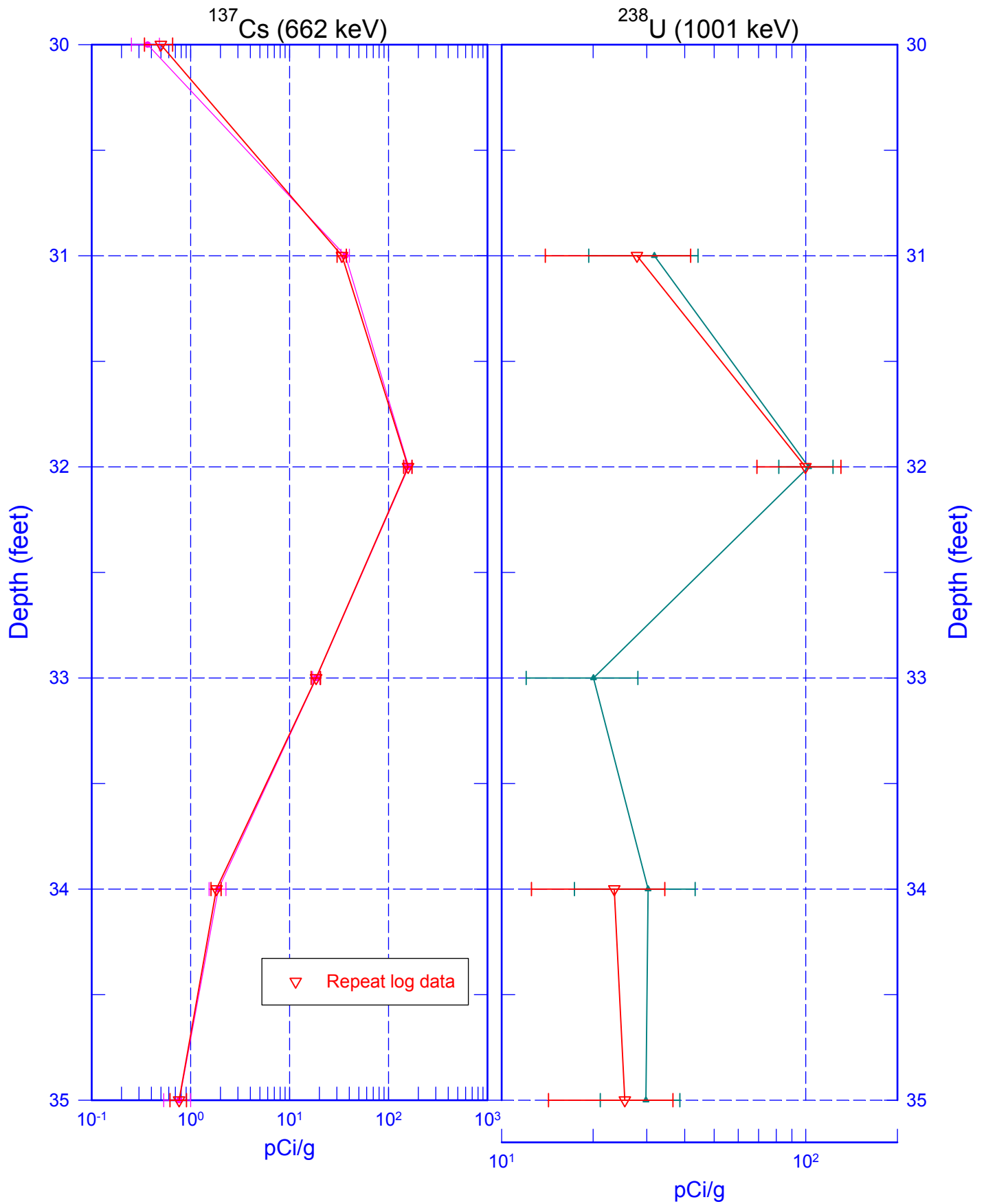
Depth scale: 1"=20 ft

Reference - Ground Surface

Last Log Date - 02/11/04



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Zero Reference = Ground Surface

Last Log Date - 02/11/04

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## Repeat Section of Natural Gamma Logs

